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CLINICAL ARTICLE

Pilot study of single-use obstetric emergency medical kits to reduce maternal mortality

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ABSTRACT

Objective: To describe the experience at a single facility regarding single-use emergency medication kits to treat obstetric emergencies in a resource-poor setting. *Methods:* A retrospective study was conducted between October 2009 and October 2010 using data from the medical records of all patients treated with a single-use obstetric emergency medical kit (E-kit) during admission at the Riley Mother and Baby Hospital Wing, Eldoret, Kenya. Descriptive analyses were performed to quantify proportions of emergencies treated using E-kits in the first year of implementation. Summary statistics regarding maternal mortality from October 2008 to October 2010 were also retrieved to evaluate differences in the maternal mortality rates in the year of E-kit implementation and the year preceding implementation in order to estimate maternal mortalities averted with E-kit implementation. *Results:* In the first year of implementation, 192 patients were treated using E-kits. Overall, 144 kits were used for treating postpartum hemorrhage, 52 for treating severe pre-eclampsia/eclampsia, and 1 for treating cardiopulmonary shock. There was a 30% reduction in maternal mortality ratio with E-kit implementation; however, results did not reach statistical significance. *Conclusion:* The results indicate that single-use E-kits may help to achieve a significant reduction in hospital rates of maternal mortality.

1. Introduction

WHO defines maternal mortality as "death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to, or aggravated by, the pregnancy or its management" [1]. Each year, an estimated 342 900 maternal deaths occur globally [2]. However, maternal deaths are not uniformly distributed throughout the world, and the burden of maternal mortality is greatest in Sub-Saharan Africa [2–4]. Indeed, between 1980 and 2008, the proportion of global maternal deaths in Sub-Saharan Africa rose from 23% to 52% [2].

Maternal mortality is the leading cause of death among women of childbearing age in Kenya [5]. In 2008, the Kenyan Demographic Health Survey estimated the national maternal mortality ratio to be 488 per 100 000 live births (95% confidence interval [CI], 333–643) [5]. At the turn of this century, 193 countries endorsed the Millennium Declaration and committed to meeting 8 Millennium Development Goals (MDGs), of which "Millennium Development Goal Five is to reduce maternal mortality by 75% between 1990 and 2015" [6,7]. However, according to a systematic analysis published in 2010 regarding progress toward MDG 5, the maternal mortality ratio remained relatively stable in Kenya between 1980 and 2008 [2]. A more recent estimate of maternal mortality in 2011 indicated a modest reduction to 294.2 per 100 000 live births (CI, 227.5–369.7) [4]. The reported reduction has been attributed primarily to a reduction in HIV-related maternal death due to the proliferation of HIV treatment programs in recent years [2–4]. Despite recent acceleration in reducing maternal mortality, Kenya is far from reaching the MDG target and there is an urgent need for innovative strategies to reduce maternal deaths.

Three delays are commonly cited as co-conspirators for maternal mortality in resource-poor settings: first, a delay in the decision to seek care; second, a delay in arrival at a health facility or delay in referral to a higher level of care; third, a delay in receiving timely and appropriate treatment [8]. Although interventions that target all 3 delays are urgently needed in order to reduce maternal mortality rates, the focus of the present pilot study was on an intervention

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that addresses primarily the delay in accessing treatment for obstetric emergencies (third delay).

2. Materials and methods

Moi Teaching and Referral Hospital, in Eldoret, is the second largest public referral hospital in Kenya and serves as the referral center for all of western Kenya. The Riley Mother and Baby Hospital Wing (RMBH), which opened in July 2009, was constructed with the aim of improving the health of women and children in western Kenya. It functions as the new maternity and newborn wing for Moi Teaching and Referral Hospital. Before 2009, the maternity ward was housed within the main hospital. The new wing houses a 17-bed labor unit, conducts approximately 8000 deliveries a year, and can accommodate up to 50 infants in the neonatal intensive-care unit. Despite the opening of the new hospital wing, staffing levels, procurement systems, and hospital administration have remained unchanged. The medication procurement system, like many in Sub-Saharan Africa [9,10], is associated with inefficiencies and the hospital experiences frequent stock-outs of essential medication and equipment, which pose a challenge in the provision of quality and timely emergency obstetric care.

Until recently, patients were required to procure medication in emergency situations from external private pharmacies. For example, misoprostol—which is an essential medicine in emergency obstetric care [11,12]—was not procured by the hospital owing to misuse and misappropriation; patients and caregivers had to buy prostaglandins from private pharmacies and bring them to the hospital if required for care. Oxytocin, normal saline, and magnesium sulfate were also often out of stock, and shortages in clean gloves, intravenous cannulae, and Foley catheters were not infrequent. Delays in finding medication led to numerous suboptimally treated hemorrhages and high puerperal mortality rates.

Given this context, there was a need to devise a system that would ensure immediate availability of emergency obstetric medication in the context of a dysfunctional supply chain, an inefficient procurement system, and a busy maternity unit.

"Crash carts" and "code boxes" have been used in emergency-room settings for many decades; however, little evidence has been published regarding their effectiveness [13–15]. To date, there are no published articles about implementing obstetric code boxes/crash carts and their effect on reducing maternal mortality. Recognizing the contribution of the third delay in causing maternal mortality, we sought to pilot single-use obstetric code boxes, called obstetric emergency medical kits (E-kits), in order to provide faster access to effective treatment during such emergencies.

According to WHO definitions of disease, the 3 most common obstetric emergencies encountered at the RMBH are postpartum hemorrhage, hypertensive emergencies (including pre-eclampsia and eclampsia), and cardiopulmonary emergencies. Each E-kit was designed to have medicines for these 3 emergencies. The E-kit is contained within a toolbox comprising 4 shelves: uterotonic medication for hemorrhage on the top shelf; medication for pre-eclampsia and eclampsia on the second shelf; medication for cardiopulmonary arrest on the third shelf; and other supplies such as gloves, syringes, needles, infusion sets, and Foley catheters on the bottom shelf (Fig. 1). Based on delivery registers, it was estimated that approximately 50 women were managed for these top 3 obstetric emergencies on a monthly basis at RMBH. To ensure uninterrupted access, 50 sealed, single-use E-kits were created. A stock of at least 50 complete E-kits is maintained at all times to ensure a 1-month buffer supply is always available, and a sealed E-kit is kept in each delivery room for ease of access. Once the seal is broken and/or medication is used, a drug consumption form contained in the E-kit is completed and the E-kit is returned to the pharmacy to be refilled and re-sealed for a new patient. Any unopened drugs or supplies are recycled for use in a new sealed E-kit. At the beginning of each nursing shift, every nurse is responsible for ensuring that there is a sealed E-kit in their assigned delivery room. A regular hospital supply of drugs and consumable commodities is available over and above the contents of the E-kits, and use of the E-kit is at the discretion of the primary nurses and doctors caring for individual patients.

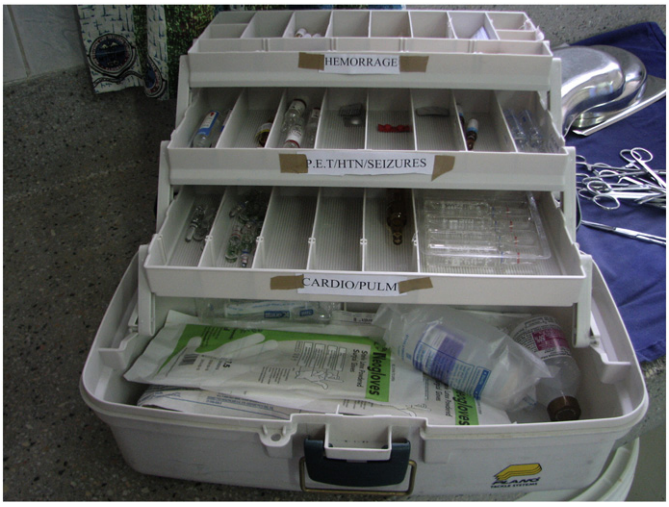

Fig. 1. Obstetric emergency medical kit (E-kit).

A retrospective study was conducted using data extracted from E-kit drug consumption forms and associated individual patient medical records to describe the outcomes of E-kit use. All women admitted to RMBH between October 15, 2009, and October 15, 2010, who were treated with an E-kit during admission were included. Any patient admitted to the hospital who did not require use of an E-kit was excluded from the study. Institutional Review Board approval was obtained from Moi University School of Medicine, Moi Teaching and Referral Hospital, and Indiana University School of Medicine.

At the beginning of E-kit implementation, in order to promote use and to ensure compliance with E-kit procedures, nurses and doctors at RMBH were oriented to the contents and the protocol for E-kit use, and encouraged to use them as needed. To ensure data quality, no E-kits are accepted for return to pharmacy unless a consumption form has been completed, thereby ensuring compliance with hospital charting policy and data collection. After return, pharmacy staff countercheck the contents of used E-kits to ensure that the drug consumption form has been accurately completed. If no E-kits are returned at the beginning of the morning nursing shift, an RMBH pharmacist circulates through the labor ward to double-check for any opened E-kits and to encourage the nurses to return them for a new sealed E-kit.

Data were extracted from all E-kit drug consumption forms to evaluate the main indications for E-kit use. The associated patient medical records were then reviewed to evaluate maternal mortality outcomes at time of hospital discharge. A de-identified database was constructed, which contained all relevant data from the E-kit drug consumption forms and patient medical records. A univariate analysis was performed to describe proportions of obstetric emergencies treated using the E-kit. Summary statistics regarding maternal mortality from the year preceding E-kit implementation (October 15, 2008, to October 15, 2009) and the first year after E-kit implementation (October 15, 2009, to October 15, 2010) were retrieved from the Moi Teaching and Referral Hospital medical statistics office to provide a comparison of mortality data between the 2 years. The medical record of each maternal mortality in the 2-year period was reviewed in detail to determine the cause of death. The mean annual hospital-based maternal mortality rate was quantified during the study period and compared with historic hospital data from the preceding year. Statistical significance was set at a P value of 0.05.

3. Results

In the year preceding E-kit implementation, there were 7080 deliveries, 6935 live births, and 27 maternal deaths at RMBH (0.38% of all deliveries, or an estimated maternal mortality ratio of 389 per 100 000 live births). In the first year of E-kit implementation, there were 8269 deliveries, 8120 live births, and 19 maternal deaths (0.2% of all deliveries, or an estimated maternal mortality ratio of 234 per 100 000 live births). Overall, there was a 30% reduction in the number of maternal mortalities, corresponding to a reduction in maternal mortality ratio of 155 per 100 000 live births, in the first year after E-kit implementation ($P=0.09$).

In the first year of implementation, 192 patients were treated using E-kits (2.3% of all deliveries). On average, 16 E-kits were used per month. Of the E-kits used, 144 (75.0%) were opened for postpartum hemorrhage, 52 (27.1%) for severe pre-eclampsia/eclampsia, and 1 (0.5%) for cardiopulmonary arrest. Eight (4.2%) E-kits were used for both postpartum hemorrhage and pre-eclampsia. The trends in drug use from E-kits are shown in Table 1.

The patient who was treated for cardiopulmonary arrest was being treated for profound anemia and retained placenta. She suffered cardiac arrest in the operating theater and was intubated during cardiopulmonary resuscitation; the medication to run the resuscitation was obtained from the E-kit. Without access to the E-kit, the anesthetist would have had to collect the necessary medication from the central pharmacy, thus delaying treatment.

In total, 46 maternal deaths occurred in the labor unit over the 2 years reviewed: 27 in the year preceding E-kits and 19 in the first year of E-kit implementation. Across both years, the main causes of death were hemorrhage (20 [43.5%]), pre-eclampsia/eclampsia (9 [19.6%]), puerperal sepsis (7 [15.2%]), cardiopulmonary failure (5 [10.9%]), and pulmonary embolism (3 [6.5%]). In the year preceding E-kit implementation, hemorrhage accounted for 51.9% (n = 14) of maternal deaths. In the first year after E-kit implementation, deaths from hemorrhage decreased to 31.6% (n = 6). The causes of death before and after E-kit implementation are shown in Fig. 2.

In the first year after E-kit implementation, there were no recorded maternal mortalities among the women treated with an E-kit. Of the 19 women who died without the use of an E-kit, 14 died of causes untreatable by E-kits (sepsis, renal failure, pulmonary embolism, uterine rupture resulting in hemorrhage, and prepartum hemorrhage). The remaining 6 deaths were from postpartum hemorrhage (n = 3) and eclampsia (n = 3).

Table 1
E-kit usage trends (n = 192).

Drug use per condition treated	No. (%)
Postpartum hemorrhage (n = 144)	
Misoprostol alone	97 (67.4)
Oxytocin alone	10 (6.9)
Ergometrine alone	2 (1.4)
One agent	109 (75.7)
Two agents	15 (10.4)
Three agents	20 (13.9)
Pre-eclampsia/eclampsia (n = 52)	
Magnesium sulfate alone	31 (59.6)
One antihypertensive agent	1 (1.9)
Two antihypertensive agents	1 (1.9)
Three antihypertensive agents	0 (0.0)
Magnesium and ≥1 antihypertensive agent	16 (30.8)
Diuretic alone	2 (3.8)
Diuretic and antihypertensive	1 (1.9)
Diuretic and magnesium	1 (1.9)
Diuretic, magnesium, and antihypertensive	0 (0.0)
Cardiopulmonary arrest (n = 1)	
Patients treated for 2 conditions	8 (4.2%) [a]

[a] Percentage of total patients.

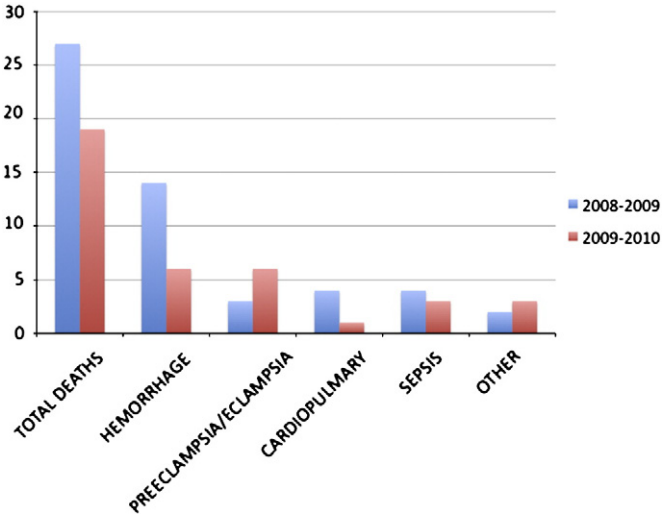

Fig. 2. Number of maternal deaths before and after E-kit implementation.

During the first year of implementation, no stock-outs of E-kits occurred and there was a consistent supply of emergency medication via the E-kit buffer system.

4. Discussion

The single-use E-kits have provided a system for immediate access to essential medication for obstetric emergencies at the study institution. The present results show that the vast majority of E-kits were used for treatment of postpartum hemorrhage with misoprostol—a drug previously unavailable for such emergencies. In addition, a large proportion of E-kits were opened to treat pre-eclampsia/eclampsia with magnesium sulfate, which is often out of stock in the main hospital pharmacy.

Introduction of the E-kits has resulted in high levels of use and translated to a reduction in maternal mortality at RMBH. Although the magnitude of reduction in hospital-based maternal mortality was substantial, the results did not reach statistical significance, and therefore they must be interpreted with caution.

The present data are retrospective, and therefore are prone to bias and confounding factors—namely, in the same period in which the E-kits were implemented, 2 other quality-improvement interventions were launched. First, in early 2010, a 5-day training course on emergency obstetric and newborn care was introduced for healthcare providers working on the maternity ward. Second, evidence-based clinical protocols for common obstetric conditions were implemented. Both of these interventions may have contributed to increased use of E-kits. However, data from meta-analyses on interventions to reduce maternal mortality have shown that training alone does not lead to significant reductions in maternal mortality and that combined interventions often result in greater impact [16,17]. Thus, we propose that a combination of all 3 interventions—training, E-kits, and the introduction of clinical protocols—contributed to the reduction in maternal mortality at the study facility.

A more rigorous evaluation of the effect of E-kits on hospital-based maternal mortality should be performed using a randomized controlled trial design. A cluster-randomized trial in which health centers are randomized to receive E-kits or standard drug supply systems could provide more robust evidence for the effectiveness of such an intervention.

Notwithstanding the retrospective nature of the pilot data presented, the E-kit represents a simple intervention that can help to address poor medication procurement systems and poor organization in maternity units. This intervention can help to ensure immediate

availability of essential emergency medication and could easily be implemented at other maternity units worldwide.

Conflict of interest

The authors have no conflicts of interest.

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